

PATENT SPECIFICATION

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DRAWINGS ATTACHED.



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COMPLETE SPECIFICATION.

Improvements in Exhaust Gas Catalytic Purifiers and Mufflers for Internal Combustion Engines.

We, AMERICAN CYANAMID COMPANY, a Corporation organized under the laws of the State of Maine, United States of America, of 30 Rockefeller Plaza, New York 20, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to catalytic apparatus of the type employable with an internal combustion engine for oxidizing the toxic and obnoxious components of hydrocarbon combustion exhaust gases.

More particularly, the present invention relates to a catalytic converter and more preferably, a catalytic converter which is capable of being readily inserted into the exhaust system of an internal combustion engine as, for example, in lieu of a muffler therein.

The exhaust gases from the combustion of hydrocarbon fuels such as gasoline, diesel fuel and the like in internal combustion engines, contain mixtures of carbon monoxide and various hydrocarbons, both saturated and unsaturated, nitrogen and other constituents. These mixtures are both poisonous and obnoxious.

In addition to the known hazards resulting from the inhalation of combustion exhaust gases of hydrocarbon fuels, such gases have, of comparatively recent times, been identified with smog formation and, to a lesser extent, with various forms of cancer.

Thus, it is known that exhaust gases from automobiles, particularly olefin and nitrogen oxide components, have been demonstrated

to be a primary cause of "photochemical smog" in heavily populated metropolitan centers. Smog, as the term is generally employed, is broadly understood to refer to a variety of phenomena which are related to the interaction of nitrogen oxides, hydrocarbons and sunlight. These include a fog-like haze, high oxidant concentration in the atmosphere (mostly ozone), eye irritation, plant damage and the like. In general, smog is defined more fully in an article by W. L. Faith, entitled "Nature of Smog" in Chemical Engineering Progress 53,406 (1957).

The hazards and nuisance created by hydrocarbon combustion exhaust gases from internal combustion engines have, over the years, resulted in a number of processes, catalysts and apparatus whereby the reduction or the elimination of the harmful components of these gases has been the primary object.

A relatively common device employed for this purpose has been what is sometimes referred to as a "catalytic muffler" which normally refers to a device which is to be substituted into the exhaust line of an internal combustion engine in lieu of a muffler. This has been a particularly preferred area of activity in view of the fact that the cost of such a device is reduced by the cost of a conventional muffler normally employed, and by other obvious advantages. Such devices are inserted into the exhaust line of an internal combustion engine and by the action of catalysts contained therein, oxidize the exhaust gases so that the exit gases from the muffler contain reduced amounts of the harmful and obnoxious constituents of the exhaust gases.

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To our knowledge, none of these devices have in the past proved successful, probably because of a number of practical considerations. Among these might be included the development of significant back pressures, the size, weight and cost of such devices, the comparative short activity life of catalysts employed and the difficulty of recharging the device with fresh catalysts, the inability of many of these devices to withstand the elevated temperatures obtained in the catalytic oxidation of exhaust gases, the difficulty in achieving uniform conditions in such devices under operating conditions and the difficulty in maintaining the catalyst bed under a constant pressure so as to prevent the formation of voids therein whereby the catalyst is rapidly and prematurely attrited and whereby catalyst is prematurely deactivated through the development of hot spots in the catalyst bed.

The present invention has for its principal object the providing of a catalytic muffler whereby uniform conditions are maintained both in the operation of the internal combustion engine and in the muffler itself by virtue of its novel design.

It is a particular object of the present invention to provide such a catalytic muffler which is of simple construction, is easily adaptable to be positioned in the exhaust line of an internal combustion engine and may be readily recharged after deactivation of the catalyst contained therein.

It is a further and particular object of the present invention to provide a catalytic muffler so constructed that losses in catalysts due to attrition are readily and automatically compensated for and whereby the presence of voids otherwise formed in a catalyst bed are automatically eliminated, thus avoiding excessive attrition and deactivation.

It is a further and particular object of this invention to provide a catalytic muffler which, in the event that excessively high temperatures are achieved during its normal operation, automatic means for permitting the ready exit of the unoxidized exhaust gases is provided.

Further objects include providing a catalytic muffler which substantially eliminates pressure drop or results in a low pressure drop due to minimum back pressure, and to provide a muffler device which effects good noise elimination.

It is a further object of this invention to provide a catalytic muffler whereby a near constant amount of air will be inducted and thus to maintain the temperature of the catalyst bed at an optimum level.

It is a further object of this invention to provide a catalytic muffler whereby the exhaust gas is selectively cooled at high engine speeds and thereby to obtain more effective control of the temperature in the

catalytic unit. It is a further object of this invention to provide a catalytic muffler in which the temperature of the catalytic unit will be maintained at a desirable level without the necessity of costly automatic temperature controls.

These objects, advantages and features of the present invention will become more apparent from the detailed description thereof set forth, which description is particularly in reference to the accompanying drawing of which:—

Figure 1 is a longitudinal cross-sectional view of the catalytic converter contemplated by this invention;

Figure 2 is a sectional view along the line 2—2 of Figure 1;

Figure 3 is an end view of the converter of Figure 1;

Figure 4 is a longitudinal cross-sectional view of another embodiment of a catalytic converter contemplated by this invention; and

Figure 5 is a longitudinal cross-sectional view of a still further embodiment of a catalytic converter contemplated by this invention.

In accordance with the present invention, there is provided a catalytic muffler comprising a cylindrical or elliptical housing having an inlet end and an outlet end, said housing having centrally positioned therein a longitudinally extending cylindrical or elliptical tube, said tube being perforated intermediate its ends, a longitudinally extending cylindrical or elliptical sleeve, said sleeve having a cross-section greater than that of said tube but less than that of said housing, the area between said sleeve and tube defining a zone for a hydrocarbon combustion exhaust catalyst, the area between the outside surface of said sleeve and the inside surface of said housing defining a space for catalytically oxidized exhaust gases to be carried to the outlet end of the housing.

The catalytic muffler of this invention is of a symmetrical design whereby uniform operating conditions are maintained for both the internal combustion exhaust engine and in the catalytic muffler itself. While catalyst mufflers of this invention are described as being cylindrical and as being of symmetrical design, it should be noted that the term cylindrical as employed herein also contemplates catalytic converters having elliptical configurations. In all of the converters of this invention the construction may further be described as being radial in that the catalyst bed extends outwardly from the center of the device where the exhaust gases enter. It is essentially this radial arrangement from which uniform operation conditions, faster warm up times, and maximum flexibility of construction are

accomplished that comprise the essential elements of this invention.

At the inlet end of the device, inside the cylindrical housing and surrounding the centrally disposed cylindrical tube through which the exhaust gases enter the catalytic chamber, a catalyst reservoir is provided which may contain, for example, between 2 and 10 per cent or more of the total volume of catalysts in the activity zone. Means are provided for maintaining a uniform and steady pressure on this catalyst reservoir as, for example, a spring which means preferably have an external or exposed element whereby pressure on the reservoir may be periodically increased as the catalyst attrits. This aspect of the present invention is particularly desirable in that it permits a user, by comparatively simple adjustment, to maintain the catalyst bed in his catalytic muffler of uniform density and thereby prevents excessive attrition and preventive deactivation of the catalyst.

At the exit end of the catalytic muffler, means are provided for closing the catalyst bed as, for example, a suitable plate-like member disposed about the central tube. In order to recharge the muffler, this plate-like member must be removed and so it may be connected to the outside end plate that this may be accomplished readily. Alternatively, such a plate-like member may be placed under pressure as for example by means of springs.

A further important aspect of this invention involves the employment of relief means whereby when the catalyst bed reaches a predetermined and undesirable intense heat, which if allowed to continue would result in the ready deactivation and possible destruction of the catalyst contained therein as well as the container; a cap or other closing means positioned at the exit end of the centrally positioned cylindrical tube is released, permitting the combustion exhaust gases to flow directly through the device without benefit of contact and oxidation by the catalyst bed. Such a means could involve a heat sensitive cap subject to melting at a predetermined temperature or, and preferably, a capping means maintained in the closed position by a heat fusible element which when a predetermined heat is reached becomes molten enabling the capping means to be opened merely by the force of unoxidized exhaust gases contacting the same.

Referring to Figures 1, 2 and 3 of the drawings, in which a specific illustrative embodiment of this invention will be described, it will be seen that a catalytic muffler A of a cylindrical configuration and a symmetrical design is shown comprising a cylindrical housing 1, preferably of a high grade heat resistant steel, though in general steels or metals, and preferably light weight metals

able to resist temperatures of up to 750° C. may be employed. Said cylindrical housing 1 has an inlet end plate 2 and an outlet end plate 3 and having extending at right angles from end plates 2 and 3 centrally positioned inlet and outlet tubes 4 and 5 respectively. Tubes 4 and 5, in general, provide a convenient means for adapting the catalytic muffler of this invention into an exhaust system of an internal combustion engine and for purposes of this description are of substantially the same diameter. With respect to tube 4, it will be noted that this tube extends into the housing 1 in a centrally disposed longitudinal plane terminating a short distance from the inside surface 6 of exit end plate 3 and in the same plane as exit tube 5. This portion of tube 4 is comprised of a major perforated segment 7 which segment may be said to comprise a major and central portion of the internal segment of tube 4.

The entrance end of tube 4 is designed in the form of a venturi whereby the combustion exhaust gases are readily mixed with air or other oxidizing gas to insure their complete oxidation. The venturi is composed of a centrally disposed tapered cone 8, the narrowed inner end 9 of which is positioned between but spaced from the inside walls of a collar-like member 10, the end of which extends inward from narrowed end 9 but is spaced from the perforation 7 in the central portion of tube 4. An opening 11 in the upper surface of the external portion of tube 4 is the entrance for air which is drawn in by the raw combustion exhaust gases entering the external end of tube 4 from the exhaust line of the internal combustion engine.

Positioned about the longitudinally extending cylindrical tube 4 is a longitudinally extending perforated heat resistant metal sleeve 12 having a cross-section greater than that of said cylindrical tube 4 but less than that of the inside diameter of housing 1. In general, the diameter of sleeve 12 will be from about 1.5 to about 3 times the diameter of tube 4. In this illustrative embodiment it is about 2.5 times. The cylindrical sleeve 12 has perforations 13 and is of a length substantially equal to the length of the internally disposed portion of tube 4. Sleeve 12 may be welded to the inside surface of inlet entrance plate 2 or otherwise supported therein by suitably positioned lugs or the like. Positioned between the outer surface of longitudinally extending tube 4 and longitudinally extending sleeve 12 is the catalyst bed 14 containing a suitable oxidizing catalyst 15. Such catalysts may be any of a number suitable for use for this purpose as, for example, an iron oxide-chromium oxide catalyst prepared from 85 to 97 per cent of Fe_2O_3 and 0.5 to about 15 per cent of Cr_2O_3 .

Exit pipe 5 is preferably joined to end 130

COMPARISON OF PERFORMANCE OF CATALYTIC CONVERTERS WITH AND WITHOUT BYPASS CONDUIT.

Speed in miles per hour.	TABLE I. % induced air in exhaust.		TABLE II. CFM air inducted		TABLE III. Total pressure drop in in. H ₂ O.		TABLE IV. Inlet % oxygen to catalytic unit.	
	With.	Without.	With.	Without.	With.	Without.	With.	Without.
15	15	17	2	3	1	1	3.8	4.2
25	15	22	4	6	3	4	4.0	4.6
30	13	25	4	9	4	6	4.0	5.2
40	10	28	5	12	5	10	4.2	7.0
50	7	28	4	15	6	16	3.6	6.2
60	6	26	3	16	8	24	2.4	5.2
75	—	—	—	—	—	—	—	—

- Inspection of the data in Table I shows that when a catalytic converter of the type of Figure 4 or 5 is employed, the percentage air inducted into the exhaust gas stream drops from a maximum at low speeds to minimum at high speeds, whereas a converter without the conduit means causes increased amount of air to be inducted with increase in speed. Further, the results appearing in Table II demonstrate that the air inducted, expressed in cubic feet per minute, varies from 2 to 5 if a converter with conduit means is employed while the amount of air inducted if a converter without conduit means is employed markedly increases from a low of 3 CFM to a high of 16 CFM. Moreover, the values for the total pressure drop shown in Table III indicate that the converter with conduit means is superior in allowing only a nominal range of variation in pressure drop to a converter without conduit means. Finally, the data tabulated in Table IV readily indicates that the percentage oxygen admitted to the catalytic unit of a converter with conduit means is at all speeds below a level of 4.5%, while levels of as high as 7.0% are achieved with a converter without conduit means. The admittance of high percentage oxygen in the latter instance to the catalytic unit of course was noted to cause an excessive rise in the temperature of the catalyst bed; i.e., the temperature was greater than 700° C. and a desirable optimum is about 600° C.
- Reproduced hereinafter in Tables V—VIII are data showing the effect of engine speed on the performance of the catalytic converter of Figure 4 or 5.
- 5
- 10
- 15
- 20
- 25
- 30
- 35

EFFECT OF ENGINE SPEED ON PERFORMANCE OF CATALYTIC CONVERTER.

Speed in miles per hour.	R.P.M.	TABLE V.		TABLE VI.		TABLE VII.		TABLE VIII.	
		Inlet HC %	Exit HC %	Inlet CO %	Exit CO %	Inlet O ₂ %	Exit O ₂ %	Inlet gas temp. ° C.	Average hot spot bed temp. ° C.
12	550	.60	.09	3.6	1.4	3.6	1.0	160	520
25	1160	.52	0.4	1.0	0.2	4.0	2.6	280	460
43	2000	.56	.02	1.4	0.2	4.4	2.4	320	500
63	2860	.60	.12	2.2	1.8	2.2	0.2	400	580
75	3500	1.70	.38	—	—	1.4	0.4	460	540

The data in Tables V and VI indicate that use of the converter achieves desirable levels of reduction of the hydrocarbon and carbon monoxide components of exhaust gases. The data in Tables V and VI is supplemented by that in Table VII showing that the oxygen admitted is being effectively utilized for the combustion of the hydrocarbon and carbon monoxide components. Finally, the results appearing in Table VIII show that while the temperature of the exhaust gas stream increases rapidly with increase in speed, nevertheless the temperature of the catalyst bed remains within an optimum and desirable range, i.e., from about 450° C. to about 600° C.

It will be evident from the present description that the use of the catalytic converter of Figure 4 or 5 results in a near constant amount of air induction whereby the temperature of the catalytic unit is maintained at an optimum level without the necessity of providing automatic temperature control. Moreover, it will be apparent that a near constant amount of air is inducted into the exhaust system without a definite high pressure drop whereby a portion of the exhaust gas stream is selectively cooled and the result is better temperature control in the catalytic unit. It will be further noted that because of the novel arrangement of the component parts, the converter is lower in cost and energy requirements than that of other air induction systems, for example, an apparatus supplying air by means of a battery driven pump.

WHAT WE CLAIM IS:—

1. A catalytic muffler comprising a cylindrical or elliptical housing having an inlet end and an outlet end, said housing having centrally positioned therein a longitudinally extending cylindrical or elliptical tube, said tube being perforated intermediate its ends, a longitudinally extending cylindrical or elliptical sleeve, said sleeve having a cross-section greater than that of said tube but less than that of said housing, the area between said sleeve and tube defining a zone for a hydrocarbon combustion exhaust catalyst, the area between the outside surface of said sleeve and the inside surface of said housing defining a space for catalytically oxidized exhaust gases to be carried to the outlet end of the housing.

2. A catalytic muffler according to Claim 1, which includes a movable disk positioned at the inlet end of the muffler, said disk being slideably fitted for longitudinal move-

ment over the centrally positioned tube, the inwardly facing surface of said disk disposed to be in contact with the catalyst in said catalyst zone, means contacting said slideably mounted disk whereby in use the catalyst bed positioned in the catalyst zone is maintained free of voids, said means having means whereby they may be adjusted from outside the muffler housing.

3. A catalytic muffler according to Claim 1 or 2, which includes a capping element covering the outlet end of the centrally disposed longitudinally extended tube, said capping means having means for retaining it in the closed position extending therefrom to the outside of said muffler, a heat sensitive element being secured to said retaining means and maintaining the capping element in the closed position.

4. A catalytic muffler according to any one of the preceding claims, which includes a venturi at the inlet end of the housing.

5. A catalytic muffler according to Claim 1, which includes a chamber having an inlet and an outlet for the passage therethrough of a hydrocarbon combustion exhaust gas stream, venturi means connected to said inlet for inducting air into said exhaust gas stream being admitted therethrough, conduit means communicating with said inlet, positioned before said venturi means and terminating at said outlet, means within said conduit for permitting the flow of at least a portion of said exhaust gas stream through said conduit, but not through said venturi means, and means for leading said gas stream from the outlet of said chamber to the inlet of the cylindrical housing.

6. A catalytic muffler according to Claim 5, in which the means within said conduit means are pressure responsive.

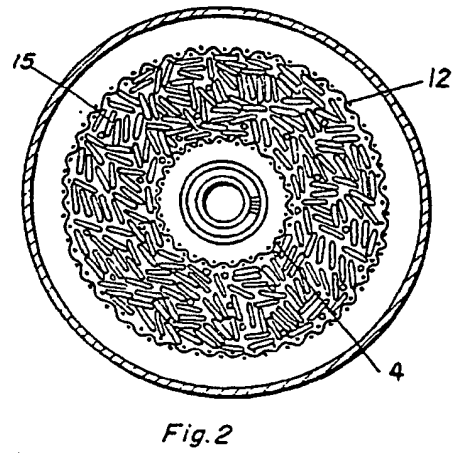
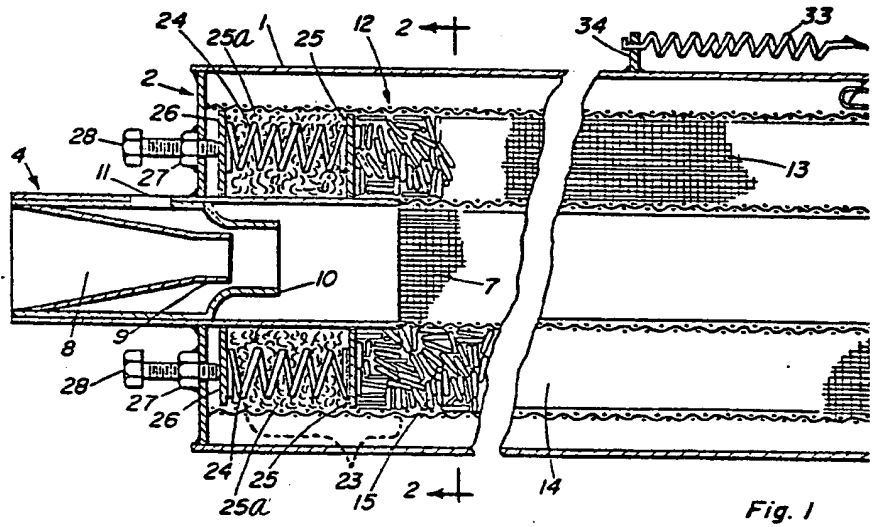
7. A catalytic muffler according to Claim 5, in which the means within said conduit means are thermally responsive.

8. A catalytic muffler according to any one of Claims 5 to 7, in which said conduit means are positioned externally of said chamber.

9. A catalytic muffler according to any one of Claims 5 to 7, in which the said conduit means are positioned internally of, coextensive with and integral with said chamber.

10. A catalytic muffler substantially as hereinbefore described and as illustrated in the accompanying drawings.

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Agents for the Applicants.



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2 SHEETS

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Sheet 1

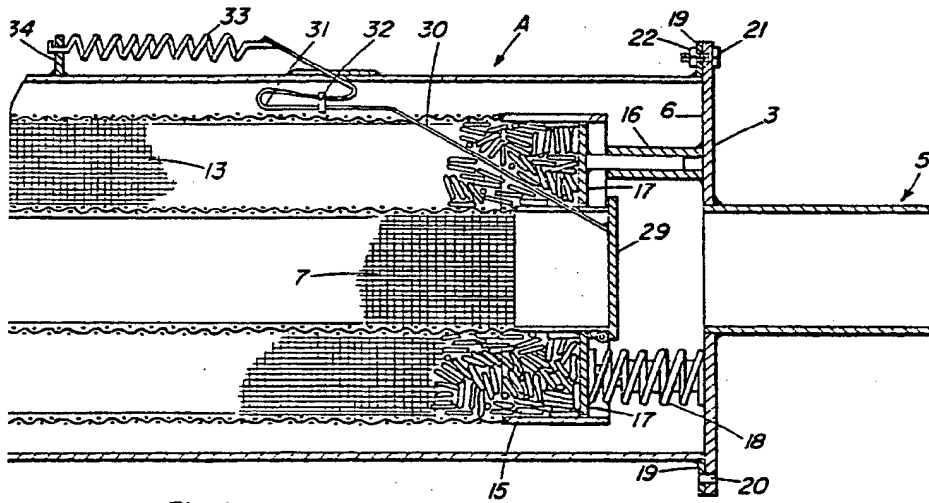


Fig. 1

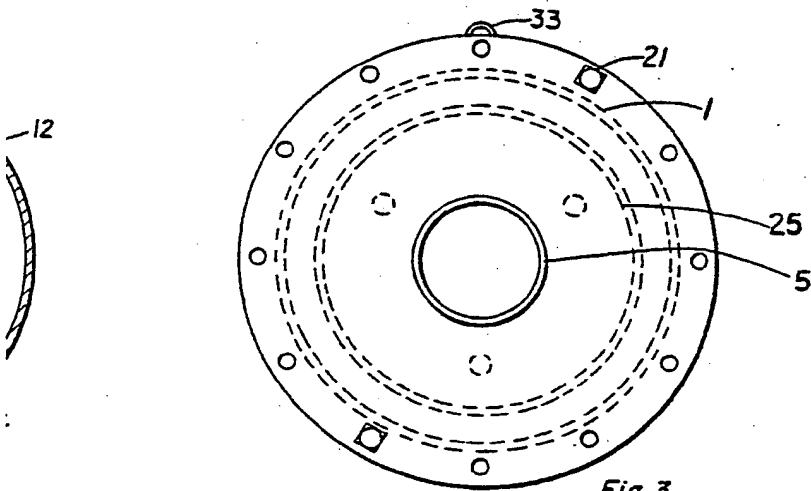
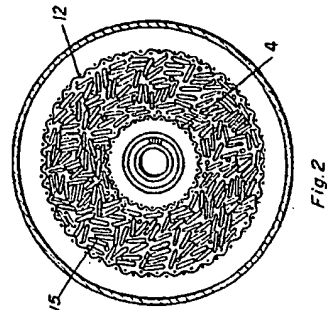
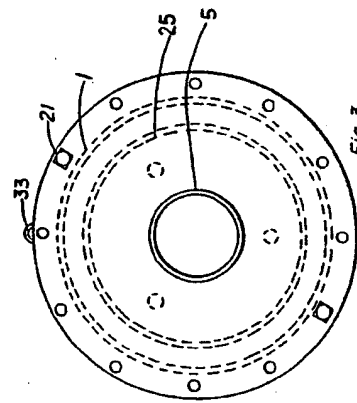
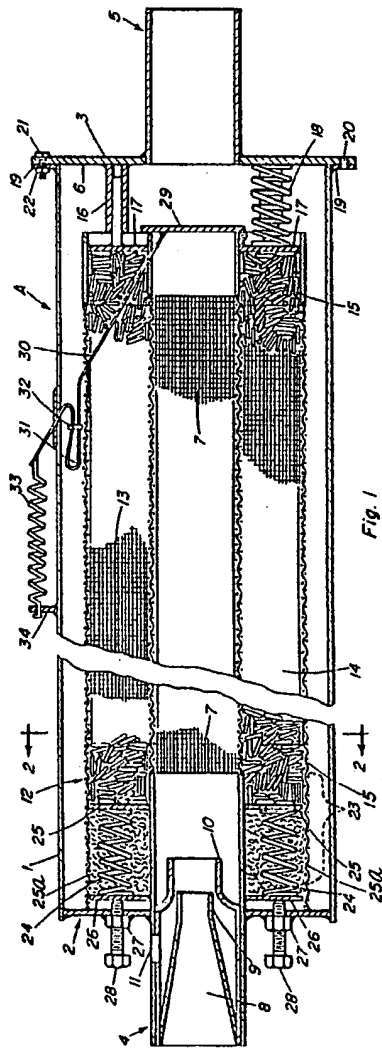
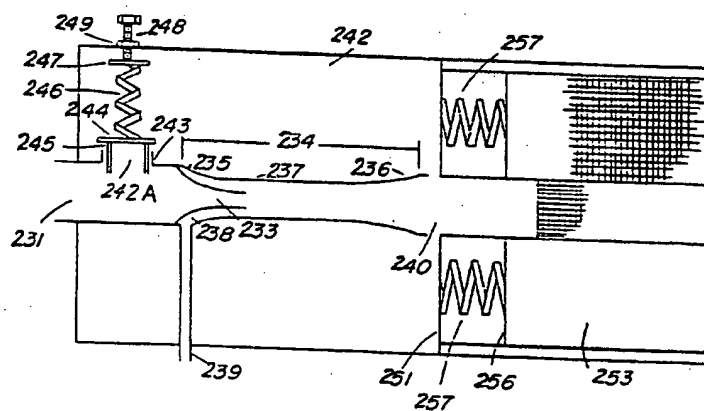
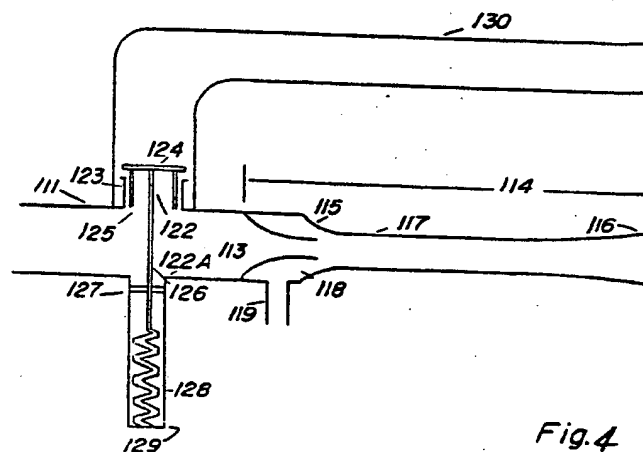


Fig. 3





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2 SHEETS

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Sheet 2

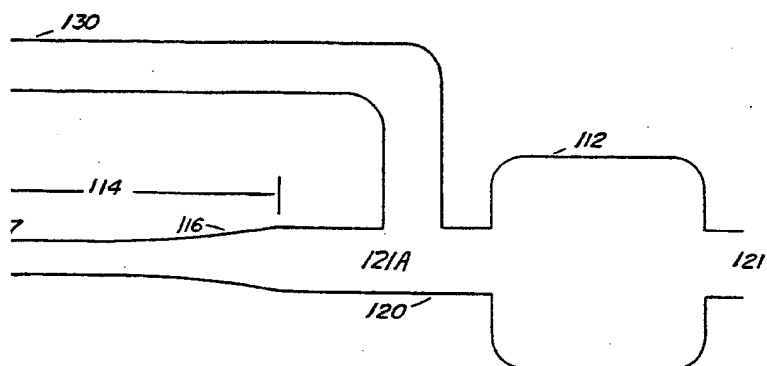


Fig. 4

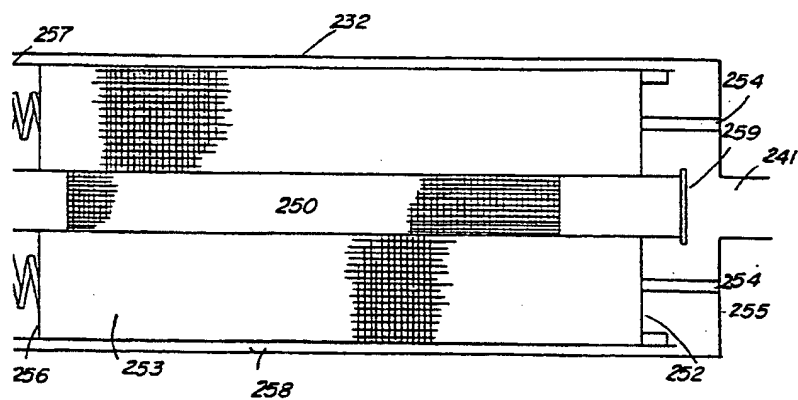


Fig. 5

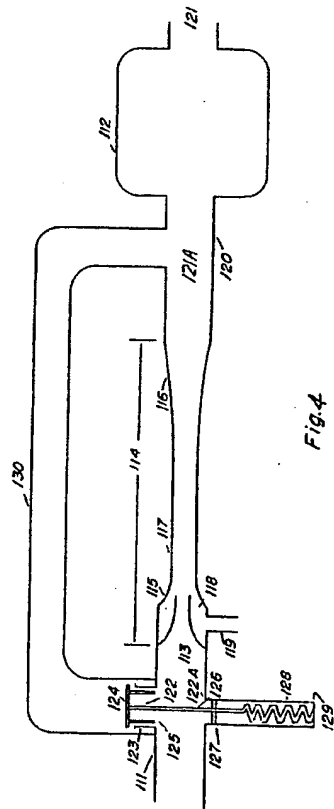


Fig. 4

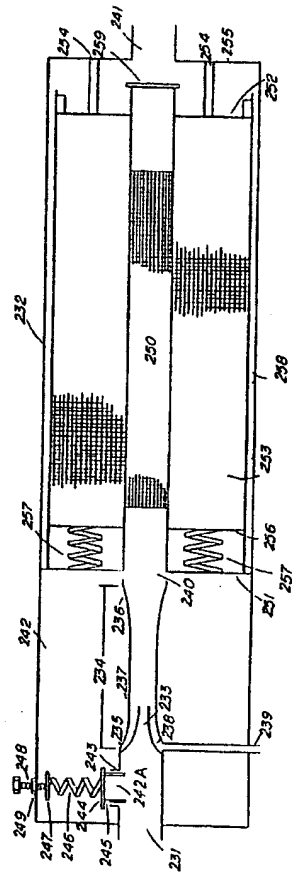


Fig. 5

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